DTU Systems Biology

Course 27008 Life Science

Ch. 12: Inheritance, Genes, and Chromosomes

Exercises for group work

Exercises for focusing on important aspects of today's topics:

Q1. Complete the below sentences using the following words (each word is only to be used once): alleles, dihybrid, dominant, F1, F2, phenotype, genotype, heterozygous, homozygous, linked, locus, recessive, exciting.

The specific location on a chromosome, where a gene is located, is called the gene's _locus_.

Genes that encode different traits within the same character (for instance purple flowers versus white flowers), and which are located in the same loci of homologous chromosomes, are called __alleles_____.

The genetic composition of an organism is called its __genotype_____, while the traits that are displayed are called its __phenotype_____.

An organism with two identical alleles at a specific locus are said to be _homozygous___ for this locus.

If, on the other hand, the two alleles differ, the organism is said to be __heterozygous___.

An allele that is displayed fully even in a heterozygous individual is called a _dominant____ allele.

Alleles that are only displayed fully in individuals that are homozygous with regards to the allele are called _recessive_____.

The progeny of the parent generation (the P generation) are called the ___F1_____ generation, while the grandchildren are called the ___F2_____ generation.

A cross between two individuals that carry different alleles in two different loci is called a ___dihybrid_____ cross.

Genes located to the same chromosome have a tendency to be inherited together. The genes are said to be _linked___.

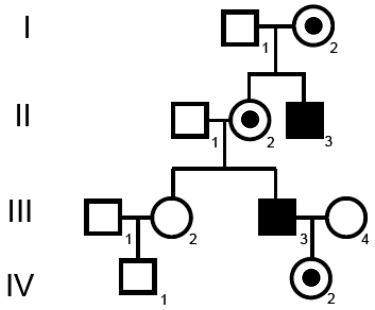
Genetics is just so _exciting__ ☺

Q2. By examining the family tree of a family in which a genetic disease occurs, it is possible to determine whether the disease is caused by a dominant or recessive allele and if it is sex-linked. What characterizes inheritance that is not sex-linked, if the disease-causing allele is, respectively, recessive or dominant?

Not sex-linked, dominant allele: The disease occurs with equal frequency in male and female. All individuals that display the disease have at least one parent, who also has the disease. Approximately half the children in the family will have the disease.

<u>Not sex-linked, recessive allele:</u> The disease occurs with equal frequency in male and female. Often, the parents of an individual with the disease are both healthy. Approximately one out of four children in the family will have the disease.

Q3. The genetic disease hemophilia occurs in the family to the right. Hemophilia is caused by a recessive, X-linked allele. Black squares symbolize men with hemophilia, white squares symbolize healthy men, and white circles symbolize healthy women. Mark the women who are definitely carriers of the recessive, disease-causing allele on one of their X chromosomes by drawing a black dot in the middle (see figure 12.24 in the textbook for an example).



Q4: Describe how bacteria exchange genetic material.

Bacteria exchange genetic material by a process called conjugation. Two bacteria in close vicinity can form a sex pilus between each other. For this to happen, one of the bacteria must contain a plasmid (fertility factor) with the genes that are necessary for conjugation (this bacteria is called F^+), while the other bacteria contains no such plasmid (this bacteria is called F^-). When the sex pilus has brought the two bacteria even closer to each other, a conjugation tube is generated between the two cells. Through this tube, DNA can be transported from the F^+ to the F^- cell. The DNA can be in the form of plasmids or chromosomal DNA. The large, chromosomal DNA is rarely transferred in its completeness, but the fragments that are transferred can be incorporated into the chromosome of the receiving bacteria by recombination.

<u>Typical exam questions (all *written* material is permitted at the exam).</u>

Q5 (1 point): In pea plants, the allele for green pods (G) dominates the allele for yellow pods (g). A pure race with green pods is crossed with a pure race with yellow pods. Which proportion of the F1 generation will have green pods? Which proportion of the F2 generation will have green pods? (Use a Punnett square to answer these questions if you like).

In the F1 generation, all plants will have green pods (genotype Gg). In the F2 generation, ¾ of the plants will have green pods (½ Gg + ¼ GG).

Q6 (1 point): In pea plants, purple flowers (B) dominate white flowers (b). Which proportion of the progeny will have purple flowers in a monohybrid cross between two plants that are both heterozygous with respect to flower color? (Use a Punnett square to answer these questions if you like).

¾ (1/2 is Bb and ¼ is BB).

Q7 (1 point): Which proportion of the progeny will have green peas, if two heterozygous plants with yellow peas are crossed? The allele for yellow peas (Y) dominates the allele for green peas (y). (Use a Punnett square to answer these questions if you like).

¼ (yy).

Q8 (1 point): If Mendel had performed experiments on cattle rather than on peas, the patterns of inheritance would not have been easily detectable because cattle (there "may" be more than one correct answer):

a. reproduce asexually
b. have small numbers of offspring
c. do not have observable phenotypes
d. do not have genotypes
e. do not have autosomes

b is the only correct answer.

Q9 (1 point): What do you call the phenomenon where the effect of one gene influences the effects of other genes?

Epistasis.

Q10 (1 point): Mark the below sentences as either true or false:

Linked genes...

a. ..must be immediately adjacent to one another in the chromosome - false

b. ..have alleles that assort independently of one another - false

c. ..are never involved in crossing over - false

d. ..are on the same chromosome - true

e. ..encode the same character - false

Question 11-12 is concerned with dihybrid crosses, where we look at both the allele for purple flowers (B), which dominates the allele for white flowers (b), and the allele for green peas (Y), which dominates the allele for yellow peas (y). The genes for flower color and pea color are not linked.

Q11 (1 point).
Which genotypes are possible for the gametes from a plant with the following genotype: BbYy.

The following four genotypes are possible: BY, By, bY, og by.

Q12 (1 point).
Which of the following crosses will result in a phenotypic ratio of 9:3:3:1 in the progeny?
A. BBYY x bbyy
B. BbYY x BBYy
C. BbYy x BbYy
D. BByy x bbYY
E. bbYY x bbyy

C: BbYy x BbYy (see fig. 12.7 s. 244).

From each of the two genotypes, four different gametes can be produced.

	BY	**By**	**bY**	**by**
BY	BBYY	BBYy	BbYY	BbYy
By	BBYy	BByy	BbYy	Bbyy
bY	BbYY	BbYy	bbYY	bbYy
by	BbYy	Bbyy	bbYy	bbyy

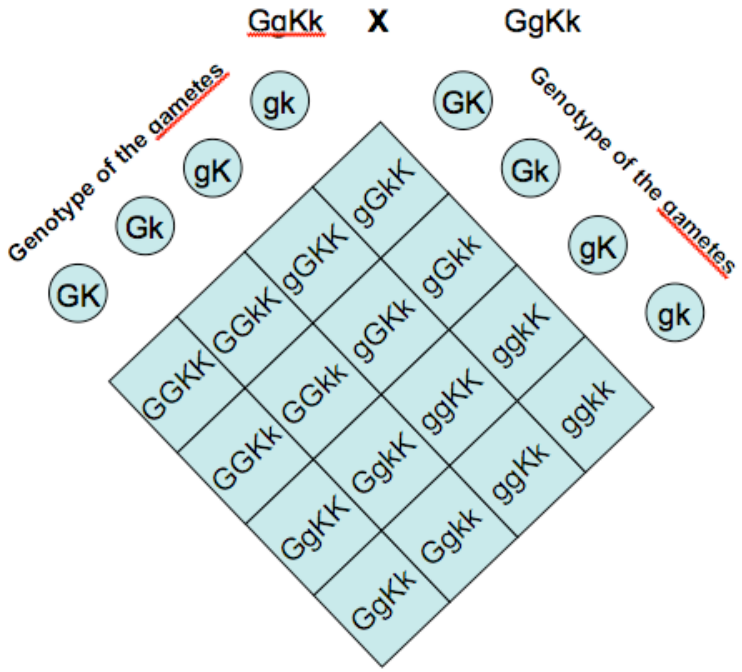
The combination of the gametes results in 9 genotypes, where both a B and a Y is present in the genotype, which will result in the same phenotype. There are three combinations, where either the B or the Y is the only dominant allele, and one possibility for no dominant alleles in the genotype. Together, the 16 genotypes thus only result in four different phenotypes in the ratio 9:3:3:1.

Q13 (1 point).
Two fruit flies with long wings are mated. Examining their progeny, it is found that 77 have long wings and 24 short wings. Is the allele encoding short wings dominant or recessive? What is the genotype of the parents?

The allele for short wings is recessive. The parents must have been heterozygous (approximately ¼ of the progeny display the recessive trait – short wings).

Q14 (2 point).
In cats, the allele for a grey fur (G) dominates the allele for a white fur (g). Also, the allele for short fur (K) dominates the allele for long fur (k). Two cats that are both heterozygous with regards to fur color and length (GgKk) are mated. Which phenotypes do you expect to see in the progeny and in which proportions, if the genes for fur color and length is unlinked? (Use a Punnett square to solve the question if you like).

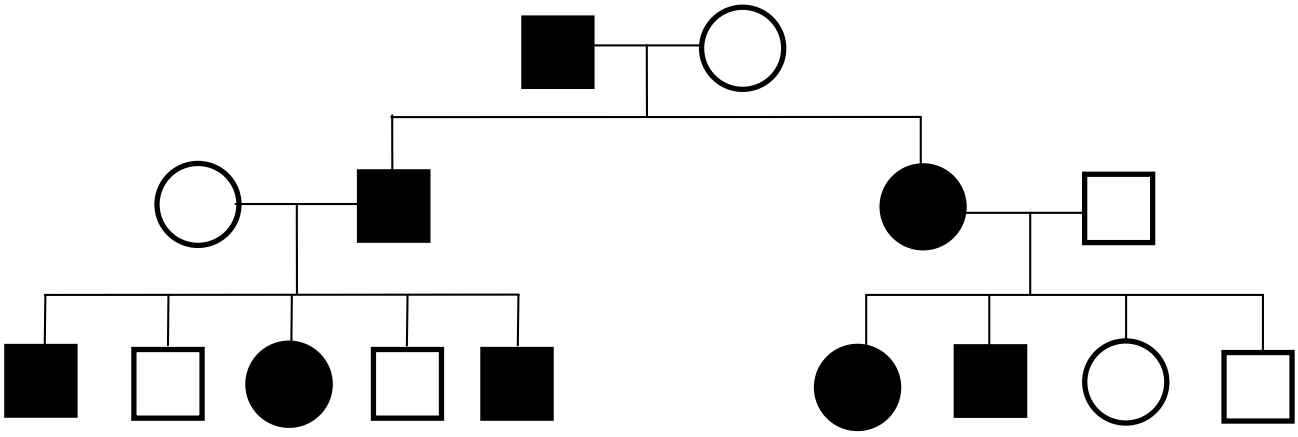
You would expect to see 9/16 cats with grey, short fur, 3/16 cats with grey, long fur, 3/16 cats with white, short fur and 1/16 cats with white, long fur.



Q15 (1 point).
This question concerns the ABO blood system. What are the possible blood types of the children of a woman with blood type A and a man with blood type B?

All blood types: A, B, AB or O, if the woman and man are both heterozygous (I^Ai^O og I^Bi^O).

Q16 (1 point).
Below, the family tree for a family in which a rare genetic disease occurs, is shown. Black squares symbolize men with the disease, white squares symbolize healthy men, black circles symbolize women with the disease, and white circles symbolize healthy women. Is the disease six-linked? Is the disease-causing allele dominant or recessive?



The disease-causing allele is not sex-linked and dominant (see the answer to Q2: The disease occurs with equal frequency in male and female. All individuals that display the disease have at least one parent, who also has the disease. Approximately half the children in the family will have the disease).